

WHAT IS CLAIMED IS

1                   1.     A       magnetic       recording       medium  
2     comprising:  
3         a first magnetic layer having a coercivity  $H_{c1}$ ;  
4         a second magnetic layer having a coercivity  
5      $H_{c2}$ ; and  
6         a non-magnetic coupling layer provided between  
7     the first and second magnetic layers so that the  
8     first and second magnetic layers are exchange-  
9     coupled and magnetizations of the first and second  
10    magnetic layers are antiparallel;  
11         said first magnetic layer having an exchange  
12    coupling field  $H_{ex1}$  that is larger than both said  
13    coercivity  $H_{c1}$  and said coercivity  $H_{c2}$ .

1                   2.     The magnetic recording medium as  
2     claimed in claim 1, wherein a switching field  $H_{sw}^*$   
3     which switches the magnetization of said first  
4     magnetic layer to become parallel to the  
5     magnetization of said second magnetic layer is set  
6     to the sum of said exchange coupling field  $H_{ex1}$  and  
7     said coercivity  $H_{c1}$ .

1                   3.     The magnetic recording medium as  
2     claimed in claim 1, wherein a magnetization and  
3     thickness product  $t_1 M_{s1}$  of said first magnetic layer  
4     is smaller than a magnetization and thickness  
5     product  $t_2 M_{s2}$  of said second magnetic layer, where  
6      $t_1$  denotes a thickness of said first magnetic layer,  
7      $M_{s1}$  denotes a magnetization of said first magnetic  
8     layer,  $t_2$  denotes a thickness of said second  
9     magnetic layer, and  $M_{s2}$  denotes a magnetization of  
10    said second magnetic layer.

1           4.     The magnetic recording medium as  
2     claimed in claim 1, wherein said coercivity Hc1 is  
3     smaller than said coercivity Hc2.

1           5.     The magnetic recording medium as  
2     claimed in claim 1, further comprising:

3           a coupling intensifying region, provided near a  
4     boundary of said first magnetic layer and said non-  
5     magnetic coupling layer, wherein said coupling  
6     intensifying region intensifies an exchange coupling  
7     strength between said first magnetic layer and said  
8     second magnetic layer.

1           6.     The magnetic recording medium as  
2     claimed in claim 5, wherein said coupling  
3     intensifying region is made of a material selected  
4     from a group consisting of Fe, Co, Ni and alloys  
5     thereof.

1           7.     The magnetic recording medium as  
2     claimed in claim 1, further comprising:

3           a coupling intensifying region, provided near a  
4     boundary of said second magnetic layer and said non-  
5     magnetic coupling layer, wherein said coupling  
6     intensifying region intensifies an exchange coupling  
7     strength between said first magnetic layer and said  
8     second magnetic layer.

1           8.     The magnetic recording medium as  
2     claimed in claim 7, wherein said coupling  
3     intensifying region is made of a material selected  
4     from a group consisting of Fe, Co, Ni and alloys  
5     thereof.

1           9.     The magnetic recording medium as  
2     claimed in claim 1, further comprising:

3           a first coupling intensifying region, provided  
4     near a boundary of said first magnetic layer and  
5     said non-magnetic coupling layer, wherein said first  
6     coupling intensifying region intensifies an exchange  
7     coupling strength between said first magnetic layer  
8     and said second magnetic layer; and

9           a second coupling intensifying region, provided  
10    near a boundary of said second magnetic layer and  
11    said non-magnetic coupling layer, wherein said  
12    second coupling intensifying region intensifies the  
13    exchange coupling strength between said first  
14    magnetic layer and said second magnetic layer.

1           10.    The magnetic recording medium as  
2     claimed in claim 9, wherein at least one of said  
3     first coupling intensifying region and said second  
4     coupling intensifying region is made of a material  
5     selected from a group consisting of Fe, Co, Ni and  
6     alloys thereof.

1           11.    The magnetic recording medium as  
2     claimed in claim 1, which is formed as a patterned  
3     medium, and wherein said first magnetic layer, said  
4     non-magnetic coupling layer and said second magnetic  
5     layer are stacked within each of a plurality of unit  
6     recording portions of the patterned medium.

1           12.    A patterned medium comprising:  
2           a recording surface; and  
3           a plurality of unit recording portions,  
4     provided on said recording surface, having  
5     boundaries which are separated from adjacent unit  
6     recording portions,  
7           each of said plurality of unit recording  
8     portions having a stacked structure comprising:

9 a first magnetic layer having a coercivity  
10 Hc1;  
11 a second magnetic layer having a  
12 coercivity Hc2; and  
13 a non-magnetic coupling layer provided  
14 between said first magnetic layer and said second  
15 magnetic layer so that said first and second  
16 magnetic layers are exchange-coupled and  
17 magnetizations of said first and second magnetic  
18 layers are antiparallel;  
19 said first magnetic layer having an  
20 exchange coupling field Hex1 which is larger than  
21 both said coercivity Hc1 and said coercivity Hc2.

1 13. The patterned medium as claimed in  
2 claim 12, further comprising:

3 a coupling intensifying region, provided near a  
4 boundary of said non-magnetic coupling layer and at  
5 least one of said first and second magnetic layers,  
6 wherein said coupling intensifying region  
7 intensifies an exchange coupling strength between  
8 said first magnetic layer and said second magnetic  
9 layer.

1 14. A magnetic storage apparatus  
2 comprising:

3 at least one magnetic recording medium; and  
4 at least one head adapted to apply a field to  
5 the magnetic recording medium;

6 said magnetic recording medium including:

7 a first magnetic layer having a coercivity  
8 Hc1;

9 a second magnetic layer having s  
10 coercivity Hc2; and

11 a non-magnetic coupling layer provided  
12 between said first magnetic layer and said second  
13 magnetic layer so that said first and second  
14 magnetic layers are exchange-coupled and

15 magnetizations of said first and second magnetic  
16 layers are antiparallel,  
17 said first magnetic layer having an  
18 exchange coupling field  $H_{ex1}$  which is larger than  
19 both said coercivity  $H_{c1}$  and said coercivity  $H_{c2}$ .

1 15. The magnetic storage apparatus as  
2 claimed in claim 14, wherein the field from said  
3 head is larger than said coercivity  $H_{c2}$  and smaller  
4 than a switching field  $H_{sw}^*$  which switches the  
5 magnetization of said first magnetic layer to become  
6 parallel to the magnetization of said second  
7 magnetic layer.

1 16. The magnetic storage apparatus as  
2 claimed in claim 15, wherein said switching field  
3  $H_{sw}^*$  is set to a sum of the exchange coupling field  
4  $H_{ex1}$  and said coercivity  $H_{c1}$ .

1 17. A magnetic storage apparatus  
2 comprising:  
3 at least one magnetic recording medium; and  
4 at least one head adapted to apply a field to  
5 the magnetic recording medium;  
6 said magnetic recording medium including:  
7 a first magnetic layer;  
8 a second magnetic layer; and  
9 a non-magnetic coupling layer provided  
10 between said first magnetic layer and said second  
11 magnetic layer so that said first and second  
12 magnetic layers are exchange coupled;  
13 wherein, during a recording process, the  
14 magnetic field applied to the recording medium is  
15 limited to a range such that magnetizations of said  
16 first magnetic layer and said second magnetic layer  
17 are maintained in either a first antiparallel state  
18 or a second antiparallel state, without entering  
19 into a parallel state, whereby in said second

20 antiparallel state the magnetizations of said first  
21 magnetic layer and said second magnetic layer are  
22 reversed, but still antiparallel, relative to the  
23 magnetizations in said first antiparallel state.

1 18. The magnetic storage apparatus as  
2 claimed in claim 17 further comprising:

3 a coupling intensifying region, provided near a  
4 boundary of said non-magnetic coupling layer and at  
5 least one of said first and second magnetic layers,  
6 wherein said coupling intensifying region  
7 intensifies an exchange coupling strength between  
8 said first magnetic layer and said second magnetic  
9 layer.

1 19. The magnetic storage apparatus as  
2 claimed in claim 17, further comprising:

3 a first coupling intensifying region, provided  
4 near a boundary of said first magnetic layer and  
5 said non-magnetic coupling layer, wherein said first  
6 coupling intensifying region intensifies an exchange  
7 coupling strength between said first magnetic layer  
8 and said second magnetic layer; and

9 a second coupling intensifying region, provided  
10 near a boundary of said second magnetic layer and  
11 said non-magnetic coupling layer, wherein said  
12 second coupling intensifying region intensifies the  
13 exchange coupling strength between said first  
14 magnetic layer and said second magnetic layer.

1 20. The magnetic storage apparatus as  
2 claimed in claim 18, wherein the coupling  
3 intensifying region includes a material dispersed  
4 within a boundary portion of at least one of said  
5 first and second magnetic layers.

1                   21. The magnetic recording medium as  
2       claimed in claim 5, wherein the coupling  
3       intensifying region includes a material dispersed  
4       within a boundary portion of at least one of said  
5       first and second magnetic layers.